ALUMINUM

Project Fact Sheet

Reduction of Annealing Times

Benefits

Success in this research effort and subsequent implementation in the domestic aluminum industry would result in:

- A total potential energy savings as high as 250 billion Btu per year
- A reduction in carbon dioxide production of 250 million cubic feet per year
- An economic benefit as much as $8.5 million per year

Applications

This technology is in direct support of the domestic aluminum industry. This research supports several important needs in the semi-fabricated aluminum sector and will provide needed fundamental information for improving the energy efficiency of hot rolling and breakdown processes.

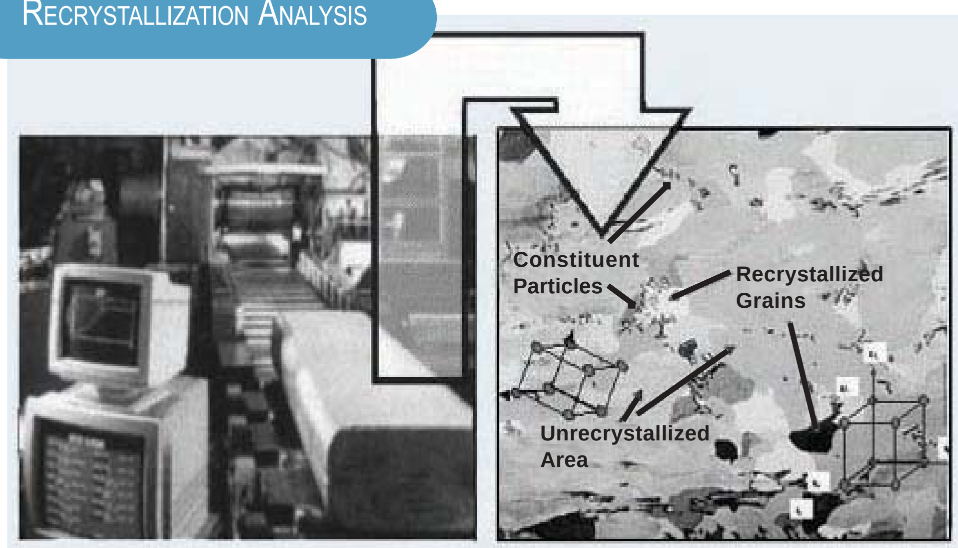
Reduction of Annealing Times for Energy Conservation in Aluminum Processing

Aluminum strip, sheet, and plate products are produced by combinations of hot and cold rolling and annealing of large ingots. On the microstructure level, these products are composed of grains of aluminum. Grain size and orientation (texture) are very significant factors in controlling the strength, working, and forming properties of the final product. The mechanical forces involved in rolling change the original grain structure of the cast ingot. Annealing aluminum by heating to 250-550^{o}C and holding it at temperature restores the desirable properties. Many times, multiple annealing steps are necessary, which requires additional resources. Reducing or eliminating annealing steps will save energy and improve productivity.

Annealing allows grain boundaries, size, and texture to reform and results in complex microstructural changes in aluminum. Most annealing is based on empirical experience. Annealing requirements vary significantly depending on the metal alloy and the amount of work performed by rolling.

Project partners will study the kinetics of the annealing and rolling processes by making detailed measurements of the crystallographic and morphology of the internal structural changes. They will exploit new tools that are available for textural and microstructural characterization to measure recrystallization kinetics and texture evolution. A better understanding of these features will be incorporated into an annealing model. Better modeling will allow shorter annealing times.

Recrystallization Analysis



Reduction of annealing times through study of recrystallization kinetics as a function of texture in hot deformation of alloys.

Project Description

Goals: The objective of this project is to provide new information on the kinetics of recrystallization in hot deformation.

This research addresses the gap in the knowledge of how recrystallization in hot deformation depends on alloy type and crystallographic texture. The scope of the project covers characterization of recrystallization kinetics and mechanisms in the early stages of hot deformation of commercial aluminum alloys. Specific goals of this project include:

- Developing automated method(s) for determining fraction recrystallized based on Orientation Imaging Microscopy (OIM) data sets.
- Measuring fraction recrystallized as a function of annealing time for all major texture components based on hot deformation in the ingot breakdown phase.
- Implementing texture-based computer simulation of recrystallization to provide a physical basis for the experimentally measured variation in recrystallization kinetics as a function of orientation.
- Providing the data required by the industrial partner to construct a constitutive model for recrystallization in hot deformation (for ingot breakdown) that includes texture information.

Progress and Milestones

Year One
- Conduct preliminary optical and scanning electron microscopy on alloys 1050 and 5005
- Complete preliminary hot deformation experiments on alloy 1050
- Construct preliminary model of recrystallization kinetics
- Complete recrystallization experiments on alloy 1050

Year Two
- Characterization of recrystallization kinetics on alloy 1050
- Complete hot deformation experiments on alloy 5005
- Develop analysis of recrystallization kinetics with model and OIM

Year Three
- Complete modeling of alloy 1050
- Complete recrystallization experiments on alloy 5005
- Conduct analysis of texture, recrystallization kinetics data
- Transfer technology to modeling group

Commercialization Plan

The commercialization path is to take fundamental knowledge gained from research on kinetic recrystallization and transfer it to a wide cross-section of the thermomechanical industry through public papers and presentations. The industrial partner in the project will assist in the implementation of this technology from laboratory-scale experiments to industrial-scale hot deformation.

Project Partners

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Alcoa Center, PA

Pennsylvania Technology Investment Authority
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